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ABSTRACT

The paper analyses issues in the hearing assessment of multihandicapped deaf-blind children. The experiences of the authors as consultants to centers for deaf-blind children are briefly noted. Advantages and disadvantages are considered for two basic approaches to hearing assessment: the electrophysiologic in which electricity from neural generators in the brain is recorded, and behavioral, in which children produce either conditioned or unconditioned responses. Among electrophysiologic approaches noted are immittance audiometry and auditory brainstem response. Procedures within behavioral assessment are reviewed, and the following aspects discussed: stimulus, waiting posture, response, reinforcement, controls, and the use of a multisensory reinforcement box. Guidelines for establishing conditioning programs with the box are offered. (CL)

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AN APPROACH TO THE AUDIOLOGIC ASSESSMENT OF MULTI-HANDICAPPED DEAF-BLIND CHILDREN

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INTRODUCTION

Following the Rubella (German measles) epidemic of the mid 1960's, approximately 30,000 children were born to mothers who had contracted this disease during pregnancy. It has been estimated that 5,000 deaf-blind children were born in the United States during that time. In addition, medical science has inadvertently contributed to the number of children born with multihandicaps by reducing infant mortality and controlling infections.

We were first introduced to deaf-blind children ten years ago as part of the visually impaired/multihandicaps diagnostic team at the University of Washington. We were faced with one of two situations:

1. children that were brought to us from Alaska, Washington, Oregon and Idaho for a single audiologic evaluation, or

2. a situation in which the hearing evaluation occurred on site at various institutions and school programs throughout the Northwestern United States.

We later served as audiology consultants to the Northwest Regional Deaf-Blind Centre and the Washington State Programs for Deaf-Blind Children. As consultants, we assessed children at various schools using small-step conditioning programs, serial testing and the assistance of the educational staff. We found success with these children when a positive attitude, a conditioning program and a team approach was utilized.

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Due to the complex nature of multisensory handicaps, visual and hearing handicapped children have traditionally gained reputations as being difficult to assess. To many educators and professionals, the deaf-blind label is fraught with terrifying connotations and often one needs to make a personal decision as to whether their efforts can do justice to this population. Some people tend to think of deaf-blind children as always being low-functioning, mentally retarded and generally noncompliant. Others think of an intelligent person who is isolated by the vision and hearing deficits. Many professionals show initial confusion or fear of failure in regards to working with this population. We remember thinking, prior to our first experience, that our reputations had been very good up until now! Our experience, however, has shown us that these initial negative feelings are unfounded. Most of the children who are labeled "deaf-blind" are rarely totally deaf or totally blind. Most commonly, the children we see are hard of hearing with field cuts or tunnel vision.

These multihandicapped/sensory-impaired children usually have enough sensory functioning to establish a basis for a conditioning paradigm if a proper approach is utilized. We have found that all conditioning programs require a waiting posture, an adequate stimulus, a consistent response and an appropriate reinforcer. These conditioning sessions sometimes continue for long periods of time before a child can be assessed. However, the time involved is well spent since the conditioned response allows accurate assessment and can be expanded to other educational areas, such as improved communication skills. The elements of conditioning will be explained in our paper and demonstrated during the slide presentation.

Certainly, if we consider audiology and special education to be professions in which we can express creativity, then the conditioning and assessment of the deaf-blind child is the essence of that thinking. We have found that many of the suspect deaf-blind children have not been given appropriate assessments, have records which are inaccurate and are often misunderstood and misdiagnosed. Children labeled as hard-to-test sometimes carry that label with them throughout their education, even when the label is not appropriate. It is not our intention today to present an academic treatise on this subject, but to explain our philosophy and approach to the auditory conditioning, audiologic assessment and interpretation of test results with low-functioning, deaf-blind children.

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HEARING ASSESSMENT

Hearing assessment with multihandicapped deaf-blind children can be broken down into two basic approaches. These are: the electrophysiologic and behavioral approaches to hearing measurement. In electrophysiologic testing, children assume a passive role in the test situation and, using electrodes on the scalp, electricity from neural generators in the brain is recorded. In the behavioral approach, children produce overt responses, either conditioned or unconditioned, and are active participants in the test situation. With some children, out of necessity, both approaches may be appropriate for obtaining the maximum amount of information regarding hearing status.

There are advantages and disadvantages to each approach. For the electrophysiologic approach, the advantages are:

1. it is rapid and information can usually be obtained in one test session;
2. for children who are unable to sit quietly, sedation can be used and, in fact, is often necessary;
3. electrophysiologic responses are "objective" responses and do not require participation of the child.

The disadvantages to the electrophysiologic approach are:

1. both the equipment and the lengthy test sessions are expensive;
2. not all frequencies can be assessed;
3. medical supervision is required for the administration of sedation and the monitoring of the sedated child;
4. equipment is often not readily available except in large population centres; and
5. the electrophysiologic approach assesses only the peripheral mechanism which provides no information regarding more central problems or the processing of auditory information.

For the behavioral approach the advantages are:

1. it is the best way to determine "hearing" since the child must somehow process auditory information to produce a response;
2. if conditioning is successfully used, the child has shown the ability to learn a task related to an auditory signal;
3. equipment for this type of testing is readily available and relatively inexpensive; and
4. all frequencies can be tested at levels which can be compared to normative values.

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The disadvantages to the behavioral approach area:

1. it is time consuming to condition children; and
2. particularly for those who are multihandicapped deaf-blind, it is not easy to get accurate behavioral information.

We have chosen the behavioral approach as the method of choice in assessing hearing in multihandicapped deaf-blind children. In addition to information regarding hearing status, it provides the audiologist, as well as the educational staff, with broad information regarding the general functioning of the child. While it is time consuming and difficult, we believe that by using systematic conditioning paradigms it is a feasible approach with many sensory-impaired children. On many occasions we do combine electrophysiolgic responses with the behavioral evaluation but only when the behavioral approach yields incomplete information regarding a child's hearing levels.

Prior to our discussion of the behavioral hearing assessment approach, we would like to present some brief information on the two electrophysiologic tools that we most often use in conjunction with the behavioral testing.

Immittance Audiometry

Immittance audiometry is an electrophysiologic procedure that provides an objective assessment of the function of the conductive part of the ear, that is, the outer ear as well as the middle ear and eardrum. Immittance audiometry has two components, tympanometry and acoustic reflex measurement.

Tympanometry measures the mobility of the ear drum by detecting its stiffness or compliance characteristics. This procedure is not a test of hearing but is an adjunct to hearing testing. From this test we can infer whether a given hearing loss might be primarily a conductive type of loss (which is, by and large, medically reversible) or a sensori-neural loss (which is primarily a permanent type). Briefly, a small, rubber probe is placed tightly in the ear canal and the air pressure against the ear drum is varied slightly. In simple terms, the equipment we use for this testing reveals whether the eardrum and middle-ear mechanism is stiffer than normal or has normal mobility. If it is adnormally stiff, the air pressure variations will have little effect on the position of the eardrum, a condition which could, for example, be caused by an ear infection with accompanying fluid in the middle ear. On the other hand, if it is abnormally mobile, it may be a result of broken or

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dislodged bones in the middle ear.

This test is an indication of where along the conductive pathway a problem may exist and, when abnormal, results in a medical referral. The actual diagnosis of the underlying pathology is then made by a physician.

The acoustic reflex is the contraction of a small muscle in the middle ear due to the presentation of sounds which are perceived as loud by the patient. The presence of this reflex is detected using the same equipment as is used for tympanometry and, in fact, is done at the same time using the probe tip in the ear canal. The detection of this reflex requires a normal tympanogram for that ear since the contraction of the muscle can only be observed in a compliant middle ear system.

From this test we can infer some information regarding hearing status. That is, the patient must hear the sound and perceive it as loud in order to trigger the reflex. However, it is possible to have a substantial amount of hearing loss and still have an acoustic reflex. Clearly we can differentiate those with some hearing from those with none. Coupled with results of behavioral testing, however, we have a very strong test battery for the presence of hearing impairment.

Auditory Brainstem Response (ABR)

The auditory brainstem response (ABR) is the recording of electrical potentials or voltages from the scalp, like a EEG test. These responses come from the VIIIth nerve and brainstem, and require a functioning middle and inner ear in order to be generated. Generally, the patient is sleeping or sedated during the test. The electrodes are taped to the skin at either the forehead or the top of the head as well as behind each ear. Brief stimuli, like clicks or tone pips, are presented through earphones placed over each ear. A computer is used to sum activity from many stimulus presentations in order to generate each brainstem response. The stimuli can be presented very rapidly and responses can be obtained every few minutes. The entire test, including sedation, takes about two to three hours. Once responses are obtained, the latency (or time characteristic) as well as the amplitude (or size) of the responses are measured. Based on previous studies of normal and abnormally hearing persons, these latency and amplitude values can then be related to decibels of hearing above threshold. Hearing levels can be estimated with fair accuracy from these responses.

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The ABR is not without its limitations, however. One drawback is that it is useful only for the assessment of high frequency hearing. Little or no information regarding low-frequency status is available by this procedure, although many deaf-blind individuals have residual hearing only in the low frequencies. Another limitation is that the ABR requires normal neurologic function to generate the synchronous neural firings for proper response recording. Neurologically impaired subjects may reveal abnormal or even absent responses and yet still have normal hearing.

Nonetheless, the ABR is the most powerful electrophysiologic test of hearing available to us today. Its strength, however, lies in its use in conjunction with a complete behavioral assessment, as well as tympanometry and acoustic reflex testing.

Behavioral Assessment

The process of behavioral assessment is made up of several levels of testing, and some diagnostic decisions can be made early in this process.

The first step in this process is to gather a careful case history combined with informal observation in the classroom. It is sometimes possible to rule out children as being hearing impaired based on this information. During the informal observation, we focus on whether or not the child is using his or her hearing and also note whether the child is responsive to other modes of stimulation such as visual or tactile. If the child does not appear to respond to sound, we begin to gather information on motor ability and possible reinforcers for use in a subsequent conditioning program. Evidence that the child may have some hearing includes localizing a sound source, ceasing behavior in the presence of sound, startling to loud sounds, and other changes of behavior that are related to auditory signals. Sometimes the case history and informal observation, combined with a brief audiologic evaluation, can strongly indicate the presence of hearing within normal limits.

The behavioral audiologic evaluation is basically made up of two separate approaches. The first approach, behavioral observation audiometry (BOA) utilizes unconditioned responses, and places heavy reliance on reflexive type behaviors which are observed in the child. The second approach utilizes a conditioning procedure in which a specific, learned task is utilized as the response mode.

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The audiologic evaluation might begin with a BOA approach in which auditory signals are presented via loudspeakers and the child's unconditioned behaviors are observed and recorded by the examiners. Common behaviors which might be observed include: localization to a sound source, evidence of sound awareness such as eye blink, eye widening, limb movement, or cessation of ongoing behavior, and, to high intensity signals, startle responses. The primary usefulness of the BOA approach is to generally categorize children into extreme positions along a continuum of hearing behaviors, from those children who are very responsive to low level sounds, to children who are not responsive to auditory stimuli at all.

Those multihandicapped children who are responsive to auditory stimuli and show, for example, the following behaviors:

1. Response to sound with some sort of consistent behavioral action at low intensity levels;
2. Consistently startles to loud sounds;
3. Normal tympanograms; and
4. Normal acoustic reflexes,

can be thought to have hearing which is within normal limits and which is adequate for communication development.

On the other hand, those children who show:

1. No behavioral responses to auditory stimuli;
2. No startle or reflexive responses to loud stimuli;
3. Normal tympanograms but no acoustic reflexes,

are felt to be clearly in the hearing-impaired category. The major limitation of BOA is that for those in this hearing-impaired category, the actual hearing level in decibels cannot be accurately estimated. There is great variability in the intensity of the signal necessary to elicit unconditioned responses among normals and hearing impaired individuals and in some cases, there is an overlap between these two populations. That is to say, developmentally-delayed children with normal hearing may initiate responses to sound at the same level as hearing-impaired children.

Our experience has shown that a large number of multihandicapped/deaf-blind children cannot be simply categorized using BOA as either normal or hearing impaired. But, rather, fall into a large grey area by revealing such auditory behaviors as:

1. Inconsistent responses to sound;
2. No behavioral responses to sound but normal acoustic reflexes;
3. Responses to sound in the classroom (observed informally) but no responses in a test situation; and/or
4. Normal startle responses to high-level signals but no responses to moderate or low-level signals and no evidence that the child uses his or her hearing.

For this substantial patient population, we believe that the conditioning approach is strongly indicated. This approach allows us to develop a definitive response pattern and allows for a more accurate hearing assessment through the use of a distinct and easily observed response action.

AUDITORY CONDITIONING

The first step toward successful conditioning is a positive attitude. The assessment team members must be patient and willing to approach the child with a small step program and not rush the conditioning process. They should plan many short conditioning sessions for the child. When you begin to work with a deaf-blind child, you must break down each task into a very small step process and be prepared to work on each step for a long period of time. Short sessions will give the educator opportunities to shape behaviors without reaching a high frustation level for the child and for the professional.

Stimulus

Since we are trying to shape the child's behavior for an audiologic evaluation, on the surface, it would seem appropriate to choose an auditory stimulus. In reality, since the child is of unknown hearing status, we have found it beneficial to combine the auditory stimulation with an accompanying vibro-tactile cue. We accomplish this through the use of high-intensity, low-frequency, auditory signals which, when presented through a loud speaker, carry both auditory and vibro-tactile information. In some cases, prior to auditory conditioning, we have initially shaped the behavior of deaf-blind children by teaching them to respond to purely tactile stimulation through the use of a hairdryer or physical touch. Once the child has learned to respond to both auditory and tactile stimulation, we alter the intensity or frequency of the presentations to eliminate the tactile portion of the stimulus. In this way we can then observe the child's responses, if any, to auditory signals alone. It is then possible to probe for auditory threshold without the accompaning tactile cue. It is very revealing to watch some

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deaf-blind children respond only when tactile cues are present, demonstrate a cessation of response behavior when only the auditory stimulus is used, and reinitiate responses when the presence of the tactile cue is resumed.

Waiting Posture

A waiting posture is also a key element of the conditioning paradigm. The waiting posture can be defined as a position where the child indicates to the examiner that he or she is in a ready-state to receive a stimulus. For example, in the standard play audiometry procedure, a normal five-year-old might be taught to place a block up to his/her ear and then place the block in a can when a tone is perceived. The waiting posture is holding the block to the ear. This signals the examiner that the child is listening and ready to respond. The waiting posture also helps the child focus on the task. With low-functioning children, the waiting posture may be as simple as hands on lap, or sitting quietly. Obviously, the child must be able to maintain the waiting posture long enough for the audiologist to probe for threshold and be taught to respond only when a stimulus is perceived. It is important not to teach the child that the waiting posture immediately leads to a response. The child must wait long enough so that presentations can be varied from a few seconds to many seconds. The examiner must vary the presentation of the stimulus during the waiting phase so as not to teach an automatic response without being cued by the stimulus. This could lead to a high amount of false-positive responses which would invalidate the test session. The child must be shaped to only respond in the presence of the stimulus and not demonstrate the response behavior in the absence of the auditory signal.

The Response

A key to successful conditioning is the selection of a learned response that is tied to the onset of the stimulus and can be differentiated from ongoing behavior. In discovering an appropriate response, the examiner must often work with the teacher, classroom aid, physical therapist or other members of the educational team to select an appropriate motor behavior. With some children, we have used a headturn response, a reaching response, arm raise, foot movement or leg swing depending on the ability of the child. It is crucial to know the child's motoric ability and functioning level. The method of teaching the response is also important. Initially, the examiner must show the child when and how to respond, slowly decreasing the assistance until the child appropriately responds on his or her own. For example, with an arm reach

response, the examiner will eventually extinguish the constant touching of the arm by moving toward a nudge at the elbow to initiate the appropriate response. Eventually, the child will be taught to enter the waiting posture; wait until the stimulus is presented and perceived; and respond in order to receive the reinforcer.

Reinforcement

The next major stage of conditioning involves the selection of reinforcement. This can be a difficult decision. It is crucial that the examiner knows the child well enough to determine what is reinforcing. Again, the educational staff must help to determine various reinforcers. Give the educational staff ownership in the conditioning process. Ask teachers and classroom aides for suggestions. Talk to parents and/or cottage staff for additional ideas. Look toward the physical or occupational therapist for support. The educational staff spends a great deal of ongoing time with the children and knows their unique likes and dislikes.

Some children prefer vibration, light, social praise, juice, food bits and/or interesting toys. We have found that a squirt gun filled with juice can be an efficient tangible reinforcer. We have also found that some children will not habituate as quickly when different reinforcers are used rather than the same one time after time. Be creative in trying new reinforcers or modifying established rewards.

Controls

When determining if multihandicapped children are conditioned and ready for a formal test, it is important to note if false-positive responses are occurring (ie., random responses without a stimulus cue). This can easily be monitored by using control intervals. A control interval is a time-frame during which it is recorded by the examiners whether the child responds in the absence of a stimulus. Approximately 25% of the presentations during the audiologic exam are control intervals. This helps to monitor whether the child is conditioned and responding appropriately. We have seen some children who learn to wait for a very brief time and automatically go from the waiting posture to the response whether a stimulus is present or not. If a stimulus is always presented immediately after the child enters the waiting posture, it would appear to the naive observer that the child is responding appropriately. In reality, the responses are likely random and more closely tied to the waiting posture than the stimulus cue.

Multisensory Reinforcement Box

One of our most successful approaches has been through the use of a device that produces vibration, light, and sound. Each stimulus can be adjusted to be presented independently or in combination. The sound can be altered for frequency and intensity. The device is built in a briefcase for easy portability. There is currently a research assessment project at the Child Development and Mental Retardation Centre, University of Washington, with Dr. Marie Thompson a professor of Special Education, where this equipment has been developed and tested with deaf-blind youngsters. We have found this equipment to be very successful as a reinforcer. It can be controlled through either a foot switch or hand-held button. The vibration and blinking light serve as reinforcers for many visual/hearing-impaired children.

During the past five years we have worked on conditioning programs for deaf-blind children with the educational staff at the Washington State School for the Blind. Ms. Jean Beary-Stolle, the speech pathologist at the State School, has noted the following suggestions for establishing conditioning with the reinforcement box.

1. Determine if the child is reinforced by or at least shows interest in lights and/or vibration.

   This may be determined with penlights and hand-held vibrators, as well as, with "the box". Will the child follow the light or reach for the vibrator or light, etc.?

2. Will the child tolerate wearing earphones?

   This step is not mandatory if sound-field testing is available but better test results can be found if each ear can be tested separately, ie., through earphones.

   To train this gradually, get the child to wear earphones for other pleasurable activities first. Some examples include having the child listen to music, wearing earphones that are plugged into a record player or tape deck. Or if the child responds to voices better, use auditory trainers and have the teacher or the child vocalize or talk into the microphone. The new "Walkman" types of radios and tape players are also excellent for training purposes. They usually come with softer and lighter headphones that are less threatening to children.

If the child does not respond well to sounds, have him participate in his favorite activities, such as, snack time or play time, with a favorite toy while wearing a set of earphones such as those used with auditory trainers, radios, etc. In conditioning this activity, gradually increase the amount of time the child is expected to wear the earphone from moments to minutes at a sitting.

If the child is very resistant and cries or rebels at the sight or touch of the phones repeatedly, don't worry about conditioning at this point. Do not let this activity be associated with bad feelings or tantrums. The purpose of the training will be defeated if the child cannot enjoy the use of the earphones.

3. Familiarize yourself with the box before introducing it to the child.

Get to know the intensities and frequencies that the box will produce. Also the lights may be adjusted to blink at different intervals separate from the control for vibration and frequency. Find out how you can produce a sound without lights. This is important for producing a sound stimulus alone. Vibration and intensity of the tones produced are in the same control; also, high frequency sounds produce very little vibration.

4. When a child can sit at a table, introduce "the box"

It is necessary for the child to sit and attend to the box. Short training sessions held two times a day may be more beneficial than requiring a child to sit for an extended period of time daily. Therefore, it is suggested that once equipment is set up and the child is at the table, conditioning for 5 - 10 minutes each session will keep the process novel and interesting.

5. Shape the child's attention to the box as a response to tones presented.

a) Present the tones without lights or vibration while the child's hands rest on his own lap or beside the box. Do not allow the child to touch the box or panel until after the tone is presented. (The whole box vibrates with the presentation of low-frequency tones. It may also vibrate the table ... a rubber mat placed under the box often helps remedy this problem. It would be difficult to know if the child

is allowed to rest his hands on the box between tone presentations.) A device, such as a knob, may be made for the child to hold to wait for tones as well. This waiting and ready posture is vital for a good assessment. The child thus indicates just when he hears the tones and eliminates many false positive responses to the stimuli.

b) Take the child's hand after the tone is presented and place it on the panel. At the same time turn on the vibration and/or lights that the child has shown interest in. Direct the child's line of vision (if he has useful vision) to the lights as the child leaves his hand on the panel.

c) Repeat this procedure with various frequencies requiring some waiting between stimuli. After four or five attempts to shape the desired response behavior, allow the child to respond on his own from the waiting posture. If he does not respond, tap his elbow or drop his hand near the panel of the box to cue the correct response.

d) Gradually fade out the cues at sufficient intensity levels of the box. It may help to add another reinforcer to the vibration or lights with some children, (ie., a bite of ice cream or praise when the child appropriately responds on his own. etc.). Sufficient intensity levels for stimulation should be those loud enough for the child to react, yet not so intense as to startle him. Sounds at intensity levels where responses (localization, vocalization, cessation of behavior, etc.) have been seen should be used during initial training sessions.

6. <u>When spontaneous responses are witnessed consistently at high intensity levels, introduce lower intensity levels and a variety of frequencies.</u>

a) A few trials of each training session should be allowed for experimenting with "new" sounds. For a good audiologic assessment to take place, reliable responses at a variety of frequencies are needed.

b) Continue with this process even after conditioning has been accomplished. Fewer sessions are needed but there should be enough to maintain the response pattern to auditory stimuli at least until the assessment is over.

7. "The box" also may be used strictly for its lights and placed to the side of the child to reinforce localization.

   This may be done by presenting a sound with a noisemaker or "the box" while the child's vision is directed forward. When he turns to the sound, the lights may be turned on flashing to reinforce the head turn. Later, the child may be conditioned to turn his/her head to the perceived sound source in order to receive visual reinforcement which is initiated after the head turn has been completed.

8. Following training without earphones, if an audiometer is available, incorporate earphones into some sessions.

   Present the tones while the headset is on the child and shape the response pattern with "the box". This step is not necessary but will prepare the child well for the audiologic assessment.

These suggestions are a compilation of ideas found to be successful for auditory response conditioning. The box" has been found to be very rewarding for most of our deaf-blind students. Although the process seems simple enough, it may take considerable time to get a good hearing assessment due to the child's readiness for conditioning. "The box," in our opinion, has been the best means available for conditioning multihandicapped children.

In conclusion, suggestions for success in the auditory conditioning of low-functioning children, include the following points:

1. Associate the conditioning sessions with a positive attitude by the staff to maintain a positive experience for the child.

2. Use short conditioning sessions in order to keep frustration and failure at a minimum.

3. Use low frequency stimuli with vibro-tactile information or pair the auditory stimuli with tactile stimulation in order to insure that the child is being stimulated during the conditioning sessions.

4. Use a familiar person with the child.

5. Use control presentations to monitor random responses (ie., false-positives).

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6. Be creative in thinking of new reinforcers or variations on original reinforcement paradigms; and

7. be sure to utilize a team approach which gives others participation in the conditioning and testing process.

These suggestions, combined with implementation of the key conditioning elements (waiting posture, stimulus, response, and reinforcer) will increase the success rate for the audiologic assessment of multihandicapped, visually and hearing impaired children.

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